higher education & training
Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

REPORT 191 PROGRAMMES

SYLLABUS

Electrical Trade Theory

N3

SUBJECT CODE:

Implementation: September 2021

CONTENTS **PAGE**

1. General aims 3

2. Specific aims 3

3. Prerequisite 3

4. Duration 3

5. Evaluation 3

6. Learning content ..... **Error! Bookmark not defined.**

7. Mark allocation in the examination as an indication of the weighting of the different modules ..... **Error! Bookmark not defined.**

Module 1: Alternating current circuit theory 7

Module 2: Domestic appliances 8

Module 3: Lighting systems 9

Module 4: Programmable logic control 10

Module 5: Direct current machines 10

Module 6: Alternating current machines 10

Module 7: Transformers 10

Module 8: Earthing systems 10

Module 9: Power management 10

Module 10: Renewable energy 10

1. Subject aims

1.1 General aims

To equip learners with relevant theoretical knowledge to enable the learners to integrate meaningfully into:

1.1.1 an electrical apprenticeship
1.1.2 an electrical learnership
1.1.3 an electrical contracting environment
1.1.4 a power utility environment

1.2 Specific aims

Learners should acquire in-depth knowledge of the following subject outcomes:

1.2.1 Alternating current circuit theory
1.2.2 Domestic appliances
1.2.3 Lighting systems
1.2.4 Programmable logic controller
1.2.5 Direct current machines
1.2.6 Alternating current machines
1.2.7 Transformers
1.2.8 Earthing systems
1.2.9 Power management
1.2.10 Renewable energy

2. Prerequisite

Learners must satisfy the following requirements:

2.1 Passed N2

3. Duration

The duration of this instructional offering is one trimester full-time, part-time or distance learning mode.

4. Evaluation

4.1 Trimester mark

Learners will write TWO formal class tests and must obtain a minimum trimester mark of 40% in order to qualify to write the final examination. The trimester mark shall be calculated as follows:

Trimester mark = 30% of Test 1 + 70% of Test 2

4.2 Examination mark

The examination for this instructional offering will be conducted at the end of each trimester and as follows:

Modules 1 = 100 marks
Duration = Three hours
Minimum pass mark = 40%
Closed book examination
Scientific (non-programmable) calculators are allowed
A formula sheet is to accompany the question paper

4.3 Promotion mark

The promotion mark shall be calculated as follows:

Promotion mark = 40% of Trimester mark + 60% of Examination mark

5. Assessment

Recall, understanding, application and evaluation are important criteria necessary to assess the learner's knowledge and understanding of the subject outcomes and shall be weighted as follows during any assessment:

Recall	Understanding	Application	Evaluation
50%	10%	25%	15%

6. Mark allocation and weight value

Module	Calculation type question	Theory and drawing type question	Weight value
1	10	08	18
2	00	12	12
3	00	08	08
4	00	05	05
5	10	05	15
6	03	07	10
7	00	10	10
8	00	10	10
9	00	07	07
10	00	05	05
TOTALS	**23**	**77**	**100%**

7. General information

7.1 The regulations as prescribed in the South African National Standard (SANS 10142-1) as amended, must be used with each relevant section of this curriculum.

7.2 All symbols and units of measurement must be in accordance with the following:

7.2.1 IEC (International Electro-technical Commission)
7.2.2 SI (International System of units)

7.3 Practical examples, realistic values and current data must be used in all calculations and explanations.

7.4 Neat, fully labelled and large drawings must be presented when such is required. The learner's artistic ability is not to be evaluated.

7.5 Learners should be encouraged to provide in their answers the number of facts according to the number of marks allocated.

7.6 For calculation type questions the following must be done:

7.6.1 State the formula used

7.6.2 Show the substitution

7.6.3 Round off all answers correct to three decimal places

7.6.4 Show the SI unit

Module 1: Alternating current circuit theory

General aim

Upon completion of this module, learners should be able to demonstrate understanding of non-sinusoidal waves, single-phase circuits, three-phase balanced and unbalanced loads, vector diagrams and resonance in AC circuits.

LEARNING CONTENT	LEARNING OUTCOMES The learner must be able to:
1.1 Non-sinusoidal waves	1.1.1 Determine the form factor of non-sinusoidal waves
1.2 Single-phase circuits	1.2.1 Explain the effects that the following components have on the current in AC circuits: • Resistors • Inductors • capacitors
	1.2.2 Explain the difference between algebraic sum and vector sum of quantities
	1.2.3 Explain the concept impedance and also calculate the impedance the impedance of the following loads: • Resistive • Inductive • Capacitive
	1.2.4 Draw waveforms and vector (phasor) diagrams for the following circuits: • Resistive • Inductive • Capacitive
	1.2.5 Explain resonance and its effect in series and parallel circuits
	1.2.6 State the detrimental effects of a poor power factor and show by means of simple diagrams how it can be corrected
1.3 Three-phase balanced loads	1.3.1 State the advantages of three-phase systems over single-phase systems
	1.3.2 Draw the waveforms and vector diagrams showing the voltage distribution in a

		three-phase system
	1.3.3	State the relationship between phase values and line values in the following types of loads: • Star-connected • Delta-connected
	1.3.4	Calculate power drawn by three-phase balanced loads
1.4 Three-phase unbalanced loads	1.4.1	Explain the difference between balanced and unbalanced loads
	1.4.2	Draw vector diagrams of three-phase unbalanced loads
	1.4.3	Explain how the total power drawn by an unbalanced load is calculated

Module 2: Domestic appliances

General aim

Upon completion of this module, learners should be able to demonstrate understanding of the wiring diagrams and operation of cooking appliances, heating appliances, water heaters, three-heat stove switches, simmerstat switches, oven thermostat switches, induction cookers and washing machines.

.LEARNING CONTENT	**LEARNING OUTCOMES** **The learner must be able to:**
2.1 Appliances	2.1.1 Explain what is an appliance
	2.1.2 Explain the two classes of appliances
	2.1.3 Explain the three categories of appliances
2.2 Cooking appliances	2.2.1 Explain the basic principle of operation of an induction cooker
	2.2.2 State the advantages and disadvantages of induction cooking
	2.2.3 Explain with the aid of suitable drawings the operation of the following: • Three-heat stove switches • Simmerstat switches

	• Oven thermostat switch
	2.2.4 Explain the principle of operation of a microwave oven
2.3 Heating appliances	2.3.1 Explain the principle of operation of the following types of space heaters: • Convection heaters • Infrared heaters • Radiant heaters • Ceramic fan forced heaters • Micathermic panel heaters
2.4 Water heaters	2.4.1 Explain the principle of operation of the following types of water heaters: • Storage tank water heater • Tank-less water heater • Heat pump water heater • Solar powered water heater • Condensing water heater
	2.4.2 Explain with the aid of a drawing the principle of operation of a geyser thermostat
2.5 Washing machines	2.5.1 Name the types of washing machines available
	2.3.2 Explain the principle of operation of the following types of washing machines: • Semi-automatic • Fully-automatic

Module 3: Lighting systems

General aim

Upon completion of this module, learners should be able to demonstrate understanding of the three basic types of lighting and the operation of the different types of lamps.

LEARNING CONTENT	**LEARNING <u>OUTCOMES</u>** **The learner must be able to:**
3.1 Types of lighting	3.1.1 Explain the following three basic types of lighting: • Ambient lighting (general lighting) • Task lighting • Accent lighting

	3.1.2 Explain with the aid of drawings the operation of the following: • Incandescent lamps • Compact fluorescent lamps • Halogen lamps • Metal halide lamps • Light emitting diode • Fluorescent tube • Neon lamps • High intensity discharge lamps

Module 4: Programmable logic controller

General aim

Upon completion of this module, learners should be able to demonstrate understanding of the function of a programmable logic controller, the components of a PLC, why is a PLC used, how it is programmed and what language is used to programme a PLC.

LEARNING CONTENT	LEARNING OUTCOMES The learner must be able to:
4.1 Programmable logic controller	4.1.1 Explain what a PLC is
	4.1.2 State the components of a PLC
	4.1.3 Explain what a PLC is used for
	4.1.4 State the language used to programme a PLC
	4.1.5 Explain how a PLC is programmed

Module 5: Direct current machines

General aim

On completion of this module, learners should be able to demonstrate understanding of the characteristic curves and application of DC motors, speed control of motors, compound motors, the emf equations of motors and generators, efficiency testing of DC machines, generator characteristics curves and motor testing.

LEARNING CONTENT	LEARNING OUTCOMES The learner must be able to:
5.1 EMF equation of motors	5.1.1 Calculate the magnitude of the back emf induced in the armature
	5.1.2 Draw the characteristic curves of motors clearly showing the following: • Flux against field current • Speed against armature current • Torque against armature current
	5.1.3 Calculate the torque exerted by the armature of a DC motor
5.2 Speed control of motors	5.2.1 Explain what is meant by the following: • Normal speed • Above normal speed • Below normal speed
	5.2.2 Explain how shunt and series motors can be made to run at the three speeds mentioned in 5.2.1 above
5.3 DC machine testing	5.3.1 Name the tests to be performed on DC machines in order to assess its condition
	5.3.2 Explain each of the tests mentioned in 5.3.2 above
5.4 EMF equations of generators	5.4.1 Draw the characteristic curves of generators clearly showing the following: • Open-circuit terminal voltage against field current • Terminal voltage against load current
	5.4.2 Calculate the magnitude of the generated emf across the armature
	5.4.3 Explain the need for compound-wound generators
5.5 Efficiency testing of DC machines	5.5.1 Name all constant and variable losses that occur in DC machines
	5.5.2 Explain why the iron parts of DC machines are laminated
	5.5.3 Calculate the efficiency of DC machines using the following methods: • Direct method (rope brake method) • Indirect method (summation of

	losses) • Regenerative method (back-to-back test)

Module 6: Alternating current machines

General aim

On completion of this module, learners should be able to demonstrate understanding of the methods used to start large three-phase induction motors, slip, actual and synchronous speeds of induction motors, the construction and operation of three-phase synchronous machines.

LEARNING CONTENT	LEARNING OUTCOMES The learner must be able to:
6.1 Starting of three-phase induction motors	6.1.1 Explain slip with regards to three-phase induction motors
	6.1.2 Calculate the following: • Slip • Synchronous speed • Actual speed
	6.1.3 Explain with the aid of circuit diagrams how three-phase induction motors are started using the following methods: • Direct-on-line starting • Reduced voltage starting • Rotor resistance starting
6.2 Synchronous alternators	6.2.1 Compare the construction of a synchronous alternator with that of a synchronous motor
	6.2.2 Explain the principle of operation of a synchronous alternator
	6.2.3 Explain with the aid of a circuit diagram how two single-phase alternators are synchronised onto a common busbar system
6.3 Synchronous motors	6.3.1 Explain the principle of operation of a synchronous motor
	6.3.2 Explain how this motor can be used to improve the overall power factor of a plant

Module 7: Transformers

General aim

On completion of this module, learners should be able to demonstrate understanding of the methods used to cool a transformer, the function of tap-changers, the protection of transformers, losses in transformers, losses in a transformer, autotransformers.

LEARNING CONTENT	LEARNING OUTCOMES The learner must be able to:
7.1 Cooling of transformers	7.1.1 Explain the need for cooling of transformers
	7.1.2 Explain the different methods used to cool a transformer
7.2 Protection of transformers	7.2.1 Explain how a transformer is protected against the following: • Moisture from entering the tank • Overloads • Short-circuits
7.3 Losses in a transformer	7.3.1 Name all losses that occur in a transformer and clearly distinguish between constant and variable losses
7.4 Autotransformers	7.4.1 Draw circuit diagrams to show a step-down and step-up autotransformer
	7.4.2 State the advantages of an autotransformer
	7.4.3 State the uses of an autotransformer

Module 8: Earthing systems

General aim

On completion of this module, learners should be able to demonstrate understanding of system and equipment earthing, earthing at power stations and substations, earthing networks, earthing of the supplier's neutral conductor and the dangers of a missing neutral conductor.

LEARNING CONTENT	LEARNING OUTCOMES The learner must be able to:

8.1 Earthing systems	8.1.1 Explain system and equipment earthing
	8.1.2 Explain earthing at power stations and substations
	8.1.3 Explain shielding conductors
8.2 Earthing networks	8.2.1 Explain with the aid of diagrams the following: • IT network • TT network • TN network
8.3 Earthing of supplier's neutral conductor	8.3.1 Explain why the supplier's neutral conductor must be earthed
	8.3.2 Explain the detrimental consequences of a missing neutral

Module 9: Power management

General aim

On completion of this module, learners should be able to demonstrate understanding of domestic and industrial billing systems, prepaid systems, methods used to improve power factor, time of use tariffs.

LEARNING CONTENT	LEARNING OUTCOMES The learner must be able to:
9.1 Domestic and industrial consumers billing systems	9.1.1 Explain energy charge of domestic consumers
	9.1.2 Explain the two-part tariff that large industrial consumers are charged
	9.1.3 Explain the advantages of pre-paid metering systems
	9.1.4 Explain the following with regards to energy usage: • Maximum demand • Time switches • Time-of-use tariffs • Ripple relays • Radio-controlled relays • Tariff MCBs • Load-shedding
9.2 Power factor correction	9.2.1 Explain with the aid of diagrams how the

	following methods are used to improve the power factor of a plant: • Capacitor banks • Synchronous condensers • Phase advancers

Module 10: Renewable energy

General aim

On completion of this module, learners should be able to demonstrate understanding of solar energy as a form of renewable energy and how direct current is converted into alternating current.

LEARNING CONTENT	LEARNING OUTCOMES The learner must be able to:
10.1 Solar energy	10.1.1 State the advantages and disadvantages of solar energy
	10.1.2 Explain how solar energy is converted into electrical energy
	10.1.3 Explain how direct current is converted into alternating current
10.2 Uninterrupted power supplies	10.2.1 Explain what is a UPS
	10.2.2 Explain the purpose of a UPS